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Effect of irrigation schedules on growth and yield of aerobic rice under varied levels of farm yard manure

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ABSTRACT

A field experiment was conducted at Zonal Agricultural Research Station, Mandya, University of Agricultural Sciences, Bangalore to study the effect of irrigation regimes in conjunction with varied levels of farm yard manure on growth and yield of aerobic rice (variety KRH-2) under Cauvery command area. The results revealed that application of farm yard manure at 20 t ha^{-1} recorded significantly higher plant height (92.81 cm) total dry matter accumulation (106.89 g hill^{-1}), more number of productive tillers hill^{-1} (27.51). Filled spikelets panicle^{-1} (132.84), grain yield (6.23 t ha^{-1}).The net returns (Rs.18080 ha^{-1}) was higher with application of FYM at 10 t ha-^{1}. Irrigation schedule at IW/CPE ratio of 2.5 recorded significantly higher plant height (89.29 cm), total dry matter accumulation (104.55 g hill^{-1}), more number of productive tillers (25.74), filled spikelets panicle^{-1} (129.17), panicle weight (3.30 g), grain yield (6.40 t ha^{-1}) and net returns (Rs.23491 ha^{-1}). The irrigation schedule at IW/CPE ratio of 1.0 i.e., once in 10-12 days recorded higher water use efficiency (52.09 kg grain ha^{-1} cm) and lower with irrigation schedule at IW/CPE ratio of 2.5 (41.31 kg grain ha^{-1} cm).

Key words: *aerobic rice, irrigation regime, farm yard manure, water use efficiency*

Rice consumes about 90 percent of the fresh water resources in Asia used for agriculture. About 80 per cent of the World's rice is grown under irrigated (55%) and rainfed lowland (25%) ecosystems, both of which depends on fresh water resources. The growing scarcity of fresh water will pose problems for rice production in future years. Hence, shifting gradually from traditional rice production system to growing rice aerobically especially in water scarce irrigated low lands can mitigate occurrence of water related problems. Information of optimum moisture regimes with varying levels of farm yard manure for maximizing yield of rice under aerobic situation are scanty. Therefore, an attempt was made to study the response of aerobic rice to varied irrigation regimes in conjunction with different levels of farm yard manure for achieving maximum production.

MATERIALS AND METHODS

A field experiment was conducted at Zonal Agricultural Research Station, Visweswaraiah Canal Farm, Mandya, Karnataka during the dry season of 2005 and 2006. The soil was red sandy loam in texture, near neutral in reaction (pH 6.98), medium in available nitrogen, (298 kg ha^{-1}), phosphorus (26.13 kg ha^{-1}) and potassium 149. 32 kg ha^{-1}. Four irrigation schedules based on irrigation water (IW)/cumulative pan evaporation (CPE) ratio (IW/CPE ratio of 2.5, 2.0, 7.5 and 1.0) as sub plot and three levels of farm yard manure (M_1-No farm yard manures, M_2-FYM at 10 t ha^{-1} and M3-FYM at 20 t ha^{-1}) as main plots were tested in a split plot design with three replications. Over night soaked seeds of cultivar KRH-2 (Karnataka rice hybrid) was manually dibbled at the rate of one seed per hill with spacing of 25 cm x 25 cm as inter and intra row spacing. At the time of sowing farm yard manure was applied as per treatment. Entire P_2O_5 and K_2O and 50 per cent of Nitrogen was applied at the time of sowing and remaining 50 percent N was given in 2 equal splits at 30 and 60 days after sowing. The field was irrigated immediately after sowing. The initial four irrigations were given commonly to all the treatments and subsequent irrigations were given to the plots based on the treatments schedule, applying 5 cm depth of water at each irrigation. Irrigation was given when the cumulative pan evaporations (CPE) reached the level of 20, 25, 33.33 and 50 mm in the case of IW/CPE ratio of 2.5, 2.0, 1.5 and 1.0 respectively. Water was measured through par shall flume of 7.5 cm throat size

set up at the experimental field and by multiplying the depth of irrigation and area of the plot, the volume of water required for each plot was arrived. The required cultural practices and plant protection measures were followed as per recommended package. Observation on growth yield, parameters and yield was recorded, data was statistically analyzed. The economics was worked out with prevailing market price.

RESULTS AND DISCUSSION

Significantly marked differences were observed in morphological parameters viz., plant height and dry matter production of rice crop up to harvest with application of farm yard manure and irrigation schedules. In pooled analysis application of FYM at 20 t ha^{-1} significantly recorded higher plant height (92.81 cm) and total dry matter accumulation (106.89 g $hill^{-1}$) at harvest (Table-1). Similar trend was noticed during the year 2005 and 2006. This might be due to application of FYM increased the soil organic carbon, which holds more moisture in soil and creation of suitable condition for better root growth and proliferation and also opportunity to extract water from larger profile area. These results are in conformity with the findings of Reddy (2000) and Rao *et al.* (2004).

Table 1. Plant height and dry matter accumulation as influenced by levels of farm yard manure and irrigation schedules at harvest in aerobic rice

Treatments	Plant height (cm)			Dry matter accumulation (g $hill^{-1}$)		
	2005	2006	Pooled	2005	2006	Pooled
Levels of Farm yard manure (M)						
M_1	74.02	78.59	76.31	62.01	63.11	62.56
M_2	81.38	90.27	85.83	83.93	93.73	88.83
M_3	88.59	97.03	92.81	104.65	109.14	106.89
S.Em±	0.44	0.41	0.39	0.54	1.86	1.10
CD (P= 0.05)	1.30	1.21	1.15	1.60	5.53	3.27
Irrigation schedules (I)						
I_1	84.96	92.96	89.29	103.52	105.58	104.55
I_2	84.20	91.00	87.58	98.93	99.45	99.19
I_3	79.19	89.29	84.25	73.54	85.81	79.67
I_4	76.96	81.27	79.12	58.12	63.79	60.95
S.Em±	0.41	0.62	0.37	1.57	2.11	1.81
C.D. (P= 0.05)	1.21	1.84	1.11	4.64	6.26	5.37
Interaction						
M_1 I_1	78.84	84.01	81.42	75.53	77.89	76.71
M_1 I_2	75.47	83.07	79.28	81.31	73.41	77.36
M_1 I_3	73.99	79.18	76.59	52.65	59.84	56.24
M_1 I_4	67.76	68.09	67.93	38.55	41.29	39.92
M_2 I_1	85.14	95.24	90.19	108.85	117.14	112.99
M_2 I_2	84.19	90.04	87.12	102.09	104.28	103.18
M_2 I_3	77.88	89.97	83.93	72.77	85.79	79.28
M_2 I_4	78.32	85.82	82.07	51.99	67.71	59.85
M_3 I_1	92.95	99.87	96.41	126.20	121.72	123.96
M_3 I_2	90.89	99.62	95.25	113.39	120.67	117.03
M_3 I_3	85.70	98.73	92.22	95.20	111.81	103.50
M_3 I_4	84.81	89.91	87.36	83.82	82.37	83.09
S.Em±						
M x I	0.71	1.07	0.65	2.71	3.65	3.08
I x M	0.76	1.02	0.68	2.44	3.67	3.05
C.D. (P= 0.05)						
M x I	2.10	3.18	1.92	8.04	10.85	9.20
I x M	3.08	3.02	2.03	7.24	10.90	8.80

M_1 – No FYM, M_2 – FYM 10 t ha^{-1}, M_3-FYM 20 t ha^{-1}; IW - Irrigation Water, CPE - Cummulative pan evaporation
I_1-IW/CPE ratio of 2.5, I_2- IW/CPE ratio of 2.0, I_3-IW/CPE ratio of 1.5, I_4- IW/CPE ratio of 1.0
M x I - Between two irrigation means at the same manure.
I X M - Between two manure means at the same or different irrigation treatments

Irrigation schedule at IW/CPE ratio of 2.5 significantly recorded higher plant height (89.29 cm) and higher dry matter accumulation (104.55 g hill^{-1}) in pooled analysis at harvest. Similar trend was noticed during the year 2005 and 2006. This might be due to increased frequency of irrigation led to effective uptake of water and nutrients leading to increased plant height. The increased in dry matter production is attributed to possible reduction in transpiration rate and normal gas exchange results in increased production of photosynthates and translocation to Sink. This is in harmony with Gowri (2005) and Kato *et al.* (2004).

Application of FYM 20 t ha^{-1} significantly recorded more productive tillers hill^{-1} (27.51) filled spikelets (132.84), panicle weight (3.23 g) and higher grain yield (6.23 t ha^{-1}) in pooled analysis. Similar trend was noticed during the year 2005 and 2006. It could be attributed to adequate supply of nutrients, higher uptake and recovery of applied nutrients with application of FYM, which in turn must have improved synthesis and translocation of metabolites to various reproductive structures of the plant. Apart from this increased dry matter accumulation coupled with better distribution in to grain would always results in higher grain yield (Table-2).

Irrigation schedule at IW/CPE ratio 2.5 recorded significantly more productive tillers hill^{-1} (25.74), filled spikelets (129.17), panicle weight (3.30 g) and grain yield (6.40 t ha^{-1}). This could be attributed to increase in growth character with adequate moisture

Table 2. Irrigation schedule and levels of Farm yard manure on yield parameters at harvest in aerobic rice

Treatments	Productive tillers (hill^{-1})			Filled spikelets panicle^{-1}			Panicle weight (g)		
	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled
Levels of Farm yard manure (M)									
M_1	15.36	15.71	15.54	90.83	97.58	94.21	2.65	3.05	2.85
M_2	21.33	24.71	23.03	110.50	114.00	112.25	2.84	3.24	3.04
M_3	26.89	28.13	27.51	129.50	136.17	132.84	3.02	3.44	3.23
S.Em±	0.40	0.26	0.22	0.82	0.69	0.29	0.03	0.04	0.31
C.D. (P= 0.05)	1.19	0.77	0.65	2.43	2.05	0.86	0.09	0.12	0.92
Irrigation schedules (I)									
I_1	24.94	26.52	25.74	124.89	133.44	129.17	3.09	3.50	3.30
I_2	24.36	25.56	24.96	122.22	130.56	126.39	3.04	3.45	3.24
I_3	18.46	20.03	20.75	103.78	108.56	106.17	2.75	3.16	2.96
I_4	16.29	15.02	15.66	90.22	91.11	90.67	2.46	2.87	2.67
S.Em±	1.44	0.35	0.28	1.09	1.00	0.61	0.05	0.05	0.04
C.D. (P= 0.05)	1.33	1.03	1.83	3.23	2.97	1.80	0.15	0.13	0.17
Interaction									
M_1 I_1	19.24	15.61	17.42	110.00	112.00	111.00	2.88	3.21	2.99
M_1 I_2	16.33	18.46	17.40	104.33	115.33	109.83	2.83	3.13	2.93
M_1 I_3	11.55	14.33	12.94	77.00	87.67	82.33	2.84	3.16	2.95
M_1 I_4	10.33	10.44	10.39	72.00	75.33	73.67	2.33	2.73	2.53
M_2 I_1	25.66	29.22	27.45	119.67	124.00	121.83	3.21	3.61	3.41
M_2 I_2	23.89	26.99	25.44	119.00	127.00	123.00	2.86	3.26	3.06
M_2 I_3	20.48	24.22	22.35	113.00	112.67	112.83	2.77	3.17	2.97
M_2 I_4	15.30	18.42	16.86	90.33	92.33	91.33	2.53	2.93	2.73
M_3 I_1	32.85	34.79	33.80	145.00	164.33	154.67	3.52	3.95	3.74
M_3 I_2	29.30	31.22	30.26	143.33	149.33	146.33	3.18	3.68	3.43
M_3 I_3	26.35	27.55	26.96	121.33	125.33	123.33	2.74	3.15	2.95
M_3 I_4	22.44	23.00	22.72	108.33	105.67	107.00	2.53	2.96	2.75
S.Em±									
M x I	0.77	0.61	0.48	1.89	1.73	1.05	0.09	0.07	0.07
I x M	0.78	0.58	0.47	1.83	1.65	0.95	0.08	0.07	0.07
C.D. (P= 0.05)									
M x I	2.30	1.78	1.43	5.60	5.15	3.12	0.27	0.22	0.20
I x M	2.31	1.73	1.40	5.42	4.90	2.83	0.25	0.22	0.20

M_1 – No FYM, M_2 – FYM 10 t ha^{-1}, M_3-FYM 20 t ha^{-1}; IW - Irrigation Water, CPE - Cummulative pan evaporation
I_1-IW/CPE ratio of 2.5, I_2- IW/CPE ratio of 2.0, I_3-IW/CPE ratio of 1.5, I_4- IW/CPE ratio of 1.0
M x I - Between two irrigation means at the same manure.
I X M - Between two manure means at the same or different irrigation treatments

availability throughout crop growth period. The results are in conformity with the findings of Guled (1993) and Avil Kumar *et al.* (2006).

Application of FYM at 20 t ha^{-1} recorded higher gross returns (Rs.38357 ha^{-1}). This might be due to higher grain yield. Higher net returns(Rs.18080 ha^{-1}) and B:C ratio (2.42) was obtained with application of farm yard manure 10 t ha-^{1} and no farm yard manure application respectively (Table-3). This is due to lower cost of cultivation. Irrigation schedule at 2.5 recorded significantly higher gross, net returns and benefit: cost ratio (Rs.39401, Rs.23491 ha^{-1} and 2.47 respectively). This might be due to higher grain yield with higher irrigation level. The similar results were reported by Thomas *et al*. (2003).

Irrigation schedule at IW/CPE ratio of 2.5 recorded higher water use 154.79 cm with lower water use efficiency (41.31 kg grain ha^{-1} cm). Whereas, irrigation schedule at IW/CPE ratio of 1.0 recorded lower total water use (91.84 cm) with higher water use efficiency (52.09 kg grain ha^{-1} cm) in pooled analysis (Table-4). Irrigation schedule at IW/CPE ratio of 1.5

Table 3. Grain yield and economics as influenced of levels of farm yard manure and irrigation schedules in aerobic rice

Treatments	Grain yield (t ha^{-1})			Gross returns	Net returns	B:C ratio
	2005	2006	Pooled	(Rs. ha^{-1})	(Rs. ha^{-1})	
Levels of Farm yard manure (M)						
M_1	4.72	5.20	4.96	30408	17849	2.42
M_2	5.46	5.90	5.68	34639	18080	2.09
M_3	6.01	6.44	6.23	38357	17798	2.01
S.Em±	0.07	0.08	0.07	198	198	0.01
CD (P= 0.05)	0.23	0.24	0.22	778	778	0.04
Irrigation schedules (I)						
I_1	6.21	6.58	6.40	39401	23491	2.47
I_2	6.03	6.42	6.22	38212	22773	2.46
I_3	4.84	5.35	5.10	31145	16546	2.13
I_4	4.53	5.04	4.78	29132	15013	2.06
S.Em±	0.06	0.06	0.06	304	303	0.02
C.D. (P= 0.05)	0.20	0.19	0.20	902	902	0.06
Interaction						
M_1 I_1	5.23	5.68	5.51	34190	18271	2.15
M_1 I_2	5.10	5.47	5.29	32745	17306	2.12
M_1 I_3	4.38	4.94	4.66	28358	13759	1.94
M_1 I_4	4.18	4.73	4.46	26788	12669	1.89
M_2 I_1	6.34	6.71	6.53	39897	19978	2.01
M_2 I_2	6.17	6.57	6.37	38914	19475	2.00
M_2 I_3	4.83	5.33	5.08	30849	12250	1.66
M_2 I_4	4.51	4.99	4.75	28943	10824	1.60
M_3 I_1	7.05	7.36	7.20	44360	20441	1.85
M_3 I_2	6.81	7.22	7.02	43191	19752	1.84
M_3 I_3	5.30	5.79	5.55	34168	11569	1.51
M_3 I_4	4.89	5.38	5.14	31737	9618	1.43
S.Em±						
M x I	0.12	0.11	0.10	526	526	0.03
I x M	0.13	0.12	0.11	497	497	0.03
C.D. (P= 0.05)						
M x I	0.37	0.32	0.31	1562	1562	0.09
I x M	0.38	0.36	0.33	1475	1475	0.09

M_1 – No FYM, M_2 – FYM 10 t ha^{-1}, M_3-FYM 20 t ha^{-1}; IW - Irrigation Water, CPE - Cummulative pan evaporation
I_1-IW/CPE ratio of 2.5, I_2- IW/CPE ratio of 2.0, I_3-IW/CPE ratio of 1.5, I_4- IW/CPE ratio of 1.0
M x I - Between two irrigation means at the same manure.
I X M - Between two manure means at the same or different irrigation treatments

and IW/CPE ratio of 1.0 is not economical and practically not feasible as they tend to be more detrimental to the crop by way of causing nearly 26 and 34 per cent reduction in grain yield respectively as compared to irrigation schedule at IW/CPE ratio of 2.5 significantly higher yield over frequent irrigation (3 to 4 days).

Table 4. Water use efficiency as influenced by irrigation schedules in aerobic rice

Irrigation schedule	Water use efficiency (kg grain ha^{-1} cm)		
	2005	2006	Pooled
IW/CPE-2.5	41.38	41.24	41.31
IW/CPE-2.0	45.07	45.01	45.04
IW/CPE-1.5	45.68	46.11	45.91
IW/CPE-1.0	51.52	52.62	52.09

in pooled analysis. These results are in conformity with findings of Guled (1993) and Singh *et al.* (2003).

The present study revealed that application of farm yard manure at 20 t ha^{-1} as moisture conservative resulted in better growth and yield parameters which led to higher grain yield, monitory returns and irrigation water savings. Irrigating the crop once in 4 to 5 day or 5 to 6 days (IW/CPE ratio of 2.5 or 2.0) during summer season found to be optimum, efficient and economical. In tile end area of irrigated command where irrigation water is available as wider interval once in (5 to 6 days) application of farm year manure at 10 t ha^{-1} was given

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